

Some Observations upon Epidemic Respiratory Diseases
in the New Zealand Expeditionary Force
with special reference to Purulent Bronchitis
by William Henry Parkes Colonel R.E.M.C.
late D.M.S. N.Z.E.F.

h. D. Th. 1919.



Some Observations upon Epidemic Respiratory
~~Diseases~~ in the New Zealand Expeditionary
Force with special reference to Purulent
Bronchitis - by W.H. Parkes, Colonel,
N.Z.M.C., late D.M.S., N.Z.E.F.

INTRODUCTION.

The extreme importance of these diseases in view of their frequent recurrence and the serious mortality attending recent epidemics among New Zealand troops suggests the subject as one suitable for comment. It is not claimed that the observations now submitted will embody many new and definite results of original research but special reference will be made to etiology, the relationship of the disease to certain acute specific fevers and the question of prophylaxis, including the methods adopted in the N.Z.E.F. to provide by inoculation a maximum of immunity.

For purpose of reference it is proposed to classify the epidemics in order of occurrence as follows:-



1. Epidemic at the N.Z. Camp, Sling, Salisbury Plain, in January and February 1918.
2. Epidemic on the troopship "Tahiti" in August and September 1918.
3. Epidemic at the N.Z. Camp, Brocton, Staffs in October 1918.

Each outbreak will be considered later under these headings, meanwhile it is advisable to take a general survey of the diseases, referring briefly to epidemiology, etiology, clinical features, pathological anatomy, prophylaxis and treatment.

NOMENCLATURE.

At the outset a difficulty arises as to nomenclature. In the large proportion of cases the condition is that of an influenzo-pneumococcal purulent bronchitis, the bronchi being found on post mortem examination to be acutely inflamed with a profuse discharge of pus from the larger tubes. Sections of lung examined show a recent congestion of the walls of the bronchi with surrounding oedema. The term "septic pneumonia" is still employed by many authorities to describe the condition but the designation might more fittingly be restricted to the group of cases with evidence of consolidation rather than to those in which the lungs reveal neither dulness or other signs of pneumonia.

There is a striking resemblance between the condition we now term "purulent bronchitis" and that known to American physicians as "interstitial broncho pneumonia". The etiology and morbid anatomy are almost identical, but in neither case is there the consolidation occurring in true pneumonia. Rufus Cole draws attention to this in an article "Pneumonia at a Base Hospital (1918)".- "In the Army camps represented in this hospital measles has been prevalent. Pneumonia occurred frequently, but not always as a sequel to measles. The nature of measles is unknown, and we have had no opportunity to learn what anatomic changes measles alone can produce. But it does produce coryza, conjunctivitis and laryngitis, and these conditions appear to predispose to infection of the respiratory tract with bacteria. This predisposition is made evident by the great proportion of the cases of the series in which streptococcus infection followed measles; but it is evident that streptococcus infection may occur in a person who has not had measles, and it is quite probable that other diseases, such as scarlet fever, predispose to its entrance in the same way as measles. When *S. haemolyticus* gained a foothold, it usually caused in this series of cases the anatomic complex called here "interstitial broncho-pneumonia". This is the same whether it is preceded by measles or scarlet fever, or by no other disease, and its

characters are due to the specific effects of the streptococcus. When lobar pneumonia followed measles, the pneumococcus was in this series accompanied by the streptococcus, and in some cases the lobar pneumonia was complicated, anatomically, by the corresponding broncho-pneumonia. Infection with the haemolytic streptococcus does not always cause an interstitial broncho-pneumonia, but may produce a patchy lobular pneumonia". "One of the most interesting features of our study of the cases in this hospital is the recognition of the invariable connection of *S. haemolyticus* with that characteristic anatomic lesion which was well known, but to which we have for convenience given the name "interstitial broncho-pneumonia". This lesion is easily recognised in all its stages by its gross appearance, since the prominent, gray, solid peri-bronchial nodules with surrounding oedema, haemorrhage, organisation and induration bear no resemblance to areas of pneumonic consolidation, which are homogeneous, solid patches, on the cut surface of which a plug of exudate projects from each alveolus. The microscopic appearance, as described above, is equally specific and characteristic, and there is no possibility of confusion with lobar or lobular pneumonia.

HISTORICAL.

It has frequently been stated that New Zealand troops have shown undue susceptibility to climatic influences. This is not borne out by facts and at this stage it may be interesting to give a short summary of the N.Z.E.F. referring to the location of the troops at various periods of the war. The official figures recently issued give the total number of men mobilized as 124,211, or 11.4 per cent of the population and 50.5 per cent of the total number of men of military age. The number sent overseas is 100,444 or 9.3 per cent of the population. Voluntary recruits numbered 91,941, or 74 per cent of the total number of men mobilized. New Zealanders who enlisted in the British and Australian Forces numbered 3,370. The total wastage of men who embarked was 40,435, including 16,302 dead and 356 prisoners, the balance being evacuated from wounds or disease.

New Zealand troops have taken part in the various campaigns from the commencement of the war and have served far afield in Samoa, Egypt, Gallipoli, Salonika, Palestine, and France. Although the health of the Force has necessarily been influenced by diseases epidemic or peculiar to certain of these regions it is not found that there has been any difference in the incidence of epidemic respiratory diseases as compared with British or troops from other Dominions and the effect of climate is therefore negligible.

EPIDEMIOLOGY.

Investigation shows that in 1914 there occurred in England a type of Influenza more virulent than in former epidemics. In this outbreak the B.influenza (Pfeiffer) was usually present and many of the cases were complicated by a fatal form of bronchitis. An epidemic characterized by similar severe symptoms raged in the United States of America in the winter of 1916-1917 and it was found that the streptococcus was usually present in the fatal cases complicated by broncho pneumonia. At that time the relationship between influenza and the serious pulmonary sequelae was recognised, also that these were especially likely to occur after recent infection with the influenza bacillus. In the "Lancet" of Sept.8th.1918, page 377, an article by Abrahams, Hallows, Eyre and French on purulent bronchitis drew attention to the association of the disease with influenza and the opinion was expressed that the chief causal factor was the symbiosis of the B.influenza and pneumococcus.

In February 1918 the first epidemic of purulent bronchitis among N.Z. troops broke out in Camp at Sling, in the Salisbury Plain area, and it was demonstrated that acute specific disease other than influenza might be a contributing factor in the development of purulent bronchitis and pneumonia. In this instance the pulmonary complications were intimately associated with an outbreak of morbilli and rubella

and it is interesting to be able to trace the origin to an American Military Camp where, it is since stated, there had been a virulent epidemic of morbilli complicated with purulent bronchitis and attended by an alarming mortality. Certain of the troopships conveying the 30th. and 32nd. reinforcements from N.Z. called at Newport News en route to England and there is every reason to believe that several of the men were in direct contact with the infected camp. The troops left the American port on December 23rd. arriving in England on January 7th. and reaching Sling Camp a day or two later. Several cases of morbilli occurred on each ship between Jan.5th. and 8th. and these were evacuated to hospital at Liverpool, On Jan.10th. a large number of men developed morbilli of a virulent type and the incidence was maintained until early in February when the outbreak steadily declined. Meanwhile pulmonary sequelae of an alarming nature and pointing to a streptococcal infection caused considerable anxiety, especially when the infection assumed an epidemic character with steadily increasing death rate. It is significant that Influenza played little or no part in this outbreak and although it was prevalent in Camp at the time no patient developed serious symptoms.

In No.2 Epidemic the outbreak was traced to direct infection at Freetown, Sierra Leone, at which port the troopship "Tahiti" called on August 22nd. en route to England. The health of the troops prior to arrival at Freetown was exceedingly good. On the date named a

Naval Conference was held aboard the "Mantua" and attended by the captains of the ships forming the convoy. The captain of the "Tahiti" sat next to the captain of the "Mantua", which ship had many influenza cases on board and several deaths had occurred. The "Tahiti" left Freetown on Aug. 26th. on which date 35 men, including the captain, reported sick with influenza, the next day 72. From that time the epidemic increased both in numbers and severity until practically the whole of the ship's company was affected. The first death occurred on Sept. 1st., and before arrival at Plymouth on the 10th. 68 cases had proved fatal. Bearing in mind the incubation period of influenza as two to three days, that the captain of the "Tahiti" after attending the Conference on the infected ship was the first to develop the disease on a ship previously free, also that communication was not allowed between the "Tahiti" and the shore, it may reasonably be assumed that the outbreak was the result of direct infection, the virus being conveyed by the captain. It was subsequently elicited that the "Mantua" sailed from Plymouth for Sierra Leone with a clean bill of health and that the first cases of influenza-bronchitis appeared when two days out from Plymouth. A very large number of men were affected and the mortality which was exceedingly high continued up to the time of the Conference.

The origin of the 3rd. epidemic cannot be traced with any certainty as influenza was present in the vicinity for some time before the outbreak in Camp.

ETIOLOGY.

The three epidemics in which these observations are based are of special interest, inasmuch as they possess distinct features as regards etiology. In each case the respiratory catarrh developed in close relationship with an antecedent specific fever but the partnership varied with each outbreak. In No.1 epidemic the pulmonary complications were of a bronchitic and septicaemic character and developed in patients suffering from either Morbilli or Rubella. In No.2 epidemic a virulent Influenza was the antecedent disease but the clinical symptoms of the sequelae coincided with those of the former group and the diagnosis was confirmed in post mortem examination. In No.3 epidemic, Influenza was also the associated disease but the pulmonary complications were chiefly of the pneumonic type.

It is difficult to determine the exact role of the virus of Influenza or other specific fevers in producing the respiratory diseases but on the evidence at present available it is reasonable to attribute the result to symbiosis of the organisms concerned. How successful such a cooperation may prove is seen in the increased virulence of the diphtheria bacillus in the presence of the streptococcus and there is every reason to believe that the rapid and fatal forms of pneumonia

now so prevalent after influenza may also be due to an increased activity of the pneumococcus in partnership with B.influenza or an even more potent organism yet unknown. There is, of course, the possibility that the symbiosis may not be direct but through the medium of a third organism. Whether this be so or how far it may influence infectivity is, at this stage of our knowledge, a matter for conjecture. It would appear that the attack of Influenza or other acute specific fever renders the patient hypersensitive to streptococcal or pneumococcal infections. Capt.F.L.Armitage, N.Z.M.C., Bacteriologist to the N.Z. Stationary Hospital, France, is of opinion that in human infections as in laboratory cultures the influenza bacillus shows its greatest power of proliferation in the presence of other organisms and is rarely found as a pure infection. It is probable that the B.influenza is not the etiological agent in the influenza but that like the streptococcus and pneumococcus it multiplies rapidly and causes a secondary infection in the soil prepared by an undiscovered organism as suggested by Nicolle and Lebailly in their report in La Presse Medicale of Oct.3rd.1918.

In certain cases of purulent bronchitis examined bacteriologically there was found a mixed infection of staphylococcus and pneumococcus but streptococci were invariably present.

It has for some time been recognised that organisms are greatly influenced in activity by environment and display widely different manifestations under varying circumstances. Examples are the B.pestis which is much more virulent in the pneumonic than bubonic type of plague, the streptococcus may cause an abscess or more serious septicaemia, the pneumococcus may be responsible for an ulcer of the cornea, a respiratory catarrh or a pneumonia and the tubercle bacillus also behaves differently according to the tissues invaded. This has been explained as due to the selective affinity of the strain, a process by which certain strains of bacteria have an affinity for certain tissues. May not the converse of this also be true and the activity of the organism be influenced by environment, a theory which would account for the varying degrees of virulence of the organism causing the condition known as influenza?

The severity of the antecedent disease, noticed especially during the 1st. and 2nd. epidemics, was an important factor in determining the virulence of the pulmonary infection by lowering the resistance of the ~~heart~~ to streptococcal or pneumococcal invasion.

Several conditions contributed to this result:-

1. Defective Racial Immunity. Of the 320 New Zealanders developing morbilli or rubella at Sling Camp, 70.5 per cent were unprotected by a previous attack of measles.

2. Unfavourable Transport Conditions. During the latter part of the voyage to England, the men were subjected to grave discomfort, when passing through the danger zone, by defective sanitation. Owing to the military exigency, the portholes were closed during the 24 hours with the exception of half an hour only. This seriously interfered with the natural means of ventilation and rendered impossible an adequate supply of pure air to the men's quarters. Such conditions at the end of a protracted voyage, when the lack of proper exercise was acutely felt, had a most debilitating effect.

3. Non acclimatization. To men accustomed to a sunny climate, the change from the heat of the tropics to the bleak cold and damp weather of the English winter was particularly trying and may have favoured the onset of disease by providing a suitable soil for infective organisms.

4. Delay in reporting sick. Although advised to consult the medical officer when not feeling well, it was rare to find men reporting sick until the appearance of a rash rendered such a course inevitable. Such delay was undoubtedly prejudicial, involving many risks which, under medical advice, would not have occurred.

5. Virulence of American infection. There is no doubt that several of the men from one of the transports visited, while at Newport News, the military

camp where a virulent form of measles complicated by purulent bronchitis prevailed. It is significant that at the termination of the incubation period these men developed a very intense form of measles, a marked contrast to the milder forms derived from other sources, also that although a large number of other than N.Z. troops were admitted to the same hospital during the same period with measles, not a single case of purulent bronchitis occurred among them.

Immediately the serious results of No.1 epidemic were reported to the War Office a deputation of the Army Sanitary Committee was appointed to visit and report upon the outbreak. A careful inspection was made of the Camp and hospitals to which the serious cases had been transferred, the history of the epidemic investigated and information elicited as to any delay in reporting sick. The deputation expressed an opinion: "That a considerable number of patients have not reported sick promptly, an attitude of mind doubtless animated by patriotic motives and by keenness of their work." The report also states: "The result has not been aided by overcrowding in the huts at Sling Camp. We are assured that cross ventilation has been maintained."

The conclusion and recommendations of the Army Commission are as follows:-

"Conclusion.

"The epidemic of measles and rubella was accom-

panied by many cases of a severe type. It is probable that the New Zealand troops had an unduly large proportion of men who had not been protected by measles in early life, and that thus the infection of the disease and of its catarrhal complications had opportunity to act in more massive dosage than would occur in a corresponding outbreak of British troops of town origin. Measles was partially introduced into this country by the N.Z. troops, subsequent cases being infected by these and probably from other cases of measles. During the voyage overcrowding and bad ventilation accentuated the catarrhal infections and there was massive infection in persons living a comparatively sedentary life. Mixed infections continued in the camp. We were informed that the men after arrival in the camp were not over-crowded and that only moderate physical exercises were carried out. We formed the opinion that the huts were well warmed, and that a sufficiency of bedding is provided.

"Recommendations.

- "1. Our recommendation as to additional pathological investigation has already been mentioned.
- "2. All catarrhs should be regarded as serious, and so far as practicable catarrhal persons should be kept in huts separate from others.
- "3. Concise and popular instruction should be given to the soldiers on the means for preventing spray infection and in regard to expectoration, as well as on personal hygiene.

"4. In huts in which measles or rubella has occurred, there should be a daily medical inspection; and in such huts every case of catarrh should be isolated.

"4. The present hospital conditions at Brimstone Bottom are satisfactory; but the patients in each ward should not be increased beyond twelve.

"(Signed) F.J.ANDERSON, Brig.General.
Chairman,

" H.R.KENWOOD, Lieut.Col., R.A.M.C.

" A.NEWSHOLME, Lieut.Col., R.A.M.C.

"Feb.28th.1918."

CLINICAL FEATURES.

From a close observation of patients during the epidemics one is impressed by certain clinical features, most marked in cases of purulent bronchitis, and it is to this type that special reference will now be directed. The clinical picture does not suggest so much an acute pulmonary inflammation as an advanced septicaemia. There is evidence of intense toxæmia, frequently a septicaemic rash and a most prominent feature is the peculiar cyanosis. This with other symptoms will be mentioned under separate headings:

1. Cyanosis.- This is invariably present even in mild cases but it assumes an almost purple or heliotrope tint in the more severe. The cyanosis was especially referred to by Lieut.Col. Herbert French, R.A.M.C., Consulting Physician to the Southern Command,

as follows:- "It was remarkable that there was such extreme cyanosis without lung consolidation." "The right heart was not dilated particularly, and there were none of the ordinary evidences of acute failure of the right side of the heart..... It seems clear that in these cases the cyanosis is due to peripheral stagnation rather than to lack of oxygenation in the lungs themselves, and death seems clearly due not to the local lesion in the lung but to a generalised septicaemia and toxæmia." A marked degree of cyanosis in a patient suffering from acute pneumonia or other pulmonary condition interfering with proper oxygenation would be associated with dyspnoea necessitating the raised position, but in these cases it is remarkable that where cyanosis was most pronounced, the patients were lying flat without great distress.

2. Mental condition. - There is great prostration and complete indifference to surroundings. Muttering delirium is frequent, often profound depression and in a number of cases a distinct suicidal tendency. One man did commit suicide by cutting his throat.

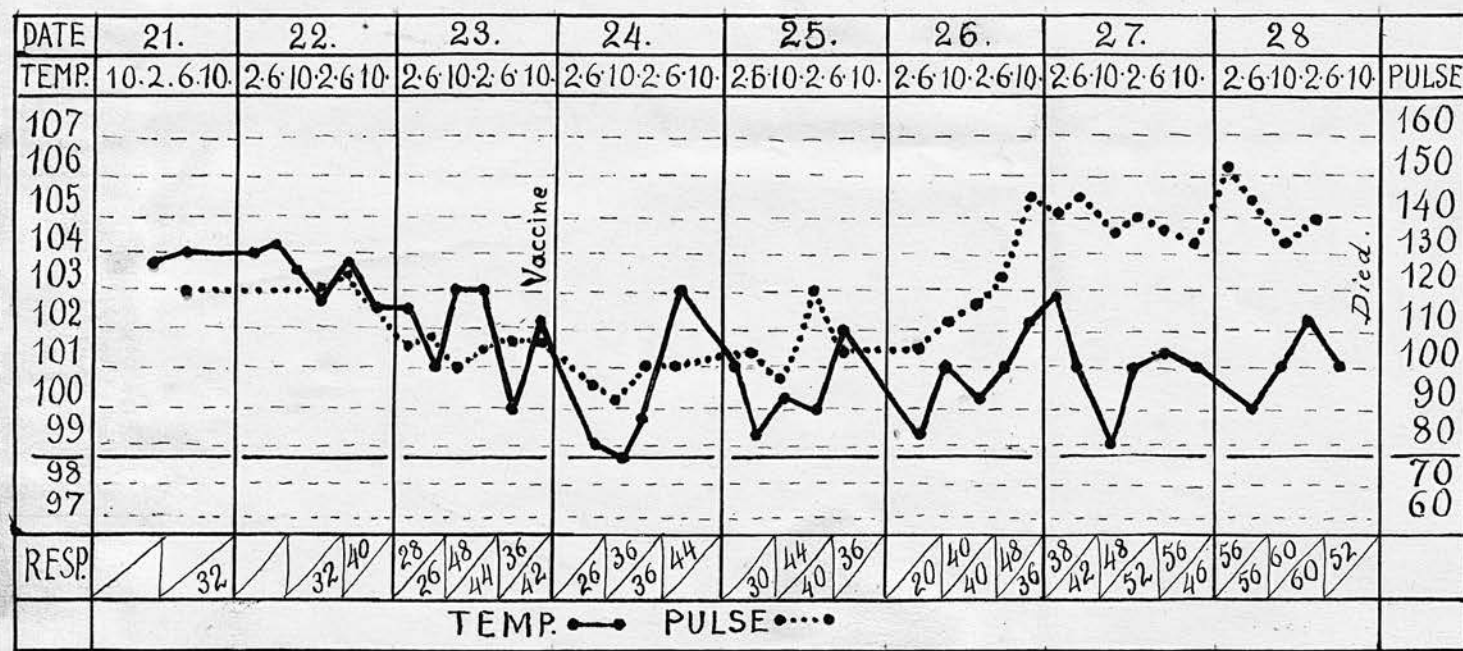
3. Odour. - In the worst cases was noticed a curious mousy odour strongly resembling that of typhus.

4. Respiration rate. - A marked feature was the high respiratory rate, in one case reaching 72 per minute and out of all proportion to the physical signs. In some of the most breathless patients there were

singularly few indications of lung involvement and certainly no consolidation.

5. Pulse.— On admission to hospital the pulse rate was generally much increased ranging from 130 in some patients with Temp. 101 R 40 to 96 in others with corresponding temperature and respiration rate. The pulse was usually poor both in volume and tension but possessed no special features.

Attached is a reduced clinical chart of a typical case of purulent bronchitis:—



6. Sputum.— This was profuse and at certain stages of the illness the patient filled two sputum cups in 24 hours. The characteristic sputum was yellow, thick and purulent, becoming frothy as improvement occurred. It was not blood stained unless the condition was complicated with pneumonia. On microscopic examination B. influenza and pus cells were

noticed and cultures give a copious growth of B. influenza with a few colonies of streptococcus and pneumococcus. According to Capt. Eagleton, R.A.M.C., B. influenza was present in 90 per cent of cases, pneumococci and staphylococcus aureus in 50 per cent of the remaining and streptococci in all.

7. Tongue. - The tongue was usually very dry, tremulous and covered with a brown fur. Sordes were often present and the tongue protruded with difficulty.

8. Aphonia. - Aphonia often associated with disphonia was a prominent symptom in a large majority of cases.

9. Physical Signs. - The physical signs differed greatly depending upon the pressure or otherwise of pneumonic consolidation. In a typical case of purulent bronchitis there was rarely any impairment of the percussion note but on auscultation one could detect harsh breath sounds with wheezing rhonchi scattered throughout both lungs and moist rales at the bases. In slighter cases there were modified vesicular breath sounds but very few rhonchi or other accompaniments. When complicated by pneumonia the usual dullness was apparent, sometimes at the bases, at other times in scattered areas over one or both lungs and the breathing assumed the usual bronchial type. Occasionally in the same patient one found a curious mixture of physical signs indicating various stages from pure bronchitis to lobar pneumonia, a condition frequently verified by autopsy.

Lieut. J.C. Fox, R.A.M.C., who was in charge of the patients from Sling Camp, in his report states:-

"The pulmonary signs varied, even in the fatal cases, from those of a bronchitis to a lobar consolidation, all intermediate stages being represented at the same time in the same individual in some cases. Clinically very few patients showed signs of pleurisy or effusion and in none did an empyema follow. In most of the fatal cases delirium was present in the later stages.

Laryngitis with disphonia or aphonia existed in 83.6 per cent of the cases, other complications diagnosed clinically were few."

In the second epidemic the more serious cases landing in England or developing pulmonary complications subsequently presented clinical features identical with those of the earlier outbreak and one had no difficulty in recognising at a glance the typical purulent bronchitis. There was the same peculiar cyanosis of purple hue, respiration increased out of proportion to the physical signs, profuse thick greenish yellow expectoration, and profound depression and prostration.

The clinical features of the third epidemic differed somewhat from the preceding outbreaks due chiefly to the greater prevalence of pneumonia as a complication. In no instance did the pure bronchitic type appear but there was the same cyanosis indicating a toxæmia due to streptococcal poisoning. The expectoration, although of a similar character, was much less in amount. A point of some interest was the disparity between the physical signs and the duration

of the illness. It was frequently noticed that although a high temperature typical of locar pneumonia continued for 8 or 9 days it was not until the 5th. or 6th. day that physical signs of the expected pneumonia appeared. This disparity was verified by post mortem examination which revealed a consolidation consistent with two or three days formation. A probably explanation of the condition is that the pneumonic process commences deep in the substance of the lung and extends gradually, the physical signs only becoming evident as the consolidation approaches the surface. It is however unusual to find so many instances of this type among a comparatively limited number of cases.

PATHOLOGICAL ANATOMY.

Ample opportunity has been afforded for post mortem examination especially during the first and second epidemics and the results compiled from official reports indicate the main pathological changes. It is not proposed to refer at this stage to the details of the bacteriological findings, but merely to the naked eye appearance of the organs usually involved.

1. Respiratory System.-

Common to all was an intense congestion of the respiratory passages suggesting a descending infection and the hyperaemia was less marked in the smaller bronchial tubes. In the larynx were small irregular ulcers usually involving the vocal cords,

the ulceration extended along the trachea and was especially noticeable at the bifurcation. The ulcers varied in depth, generally passing through the mucosa which was necrosed.

(a) Pleurae.-- In most of the cases there were distinct petechae on the lung surface especially along the interlobar fissures and towards the base. Fibrinous pleurisy was usually present and in some instances extensive adhesions, but rarely free fluid in the pleural sacs. Pus was prominent as a deposit in the pleural surface of the lung.

(b) Bronchial Glands.-- The bronchial glands were enlarged and deeply congested in all cases.

(c) Lungs.-- On section there was a free escape of thick purulent fluid from the tubes and this was quite characteristic of the bronchitic type. The bronchioles were usually dilated and thickened, the lumen being often blocked with thick pus. The condition of the lungs varied considerably, generally the right was more affected than the left but the right middle lobe escaped. In the majority of cases there was no evidence of consolidation, in others definite areas of pneumonia existed; usually of the lobular form, sometimes apical, but more frequently occurring towards the base. It was not uncommon to find in the same lung different types and stages of the inflammatory process from a lobar consolidation at the base to a pure bronchitis in the upper part, the intervening area showing gradations of irregular but

diminishing patches of broncho pneumonia. Hypostatic congestion at the base was a common feature.

2. The Heart.-

Distension of the pericardium with slightly turbid fluid was frequent and on opening the sac a fibrinous deposit on the pericardial surface was noticed.

The heart muscle was in most instances pale and friable with indications of degenerative change. The right side was usually dilated and the chambers filled with clot. The valves were normal.

3. The Spleen.-

In a few cases this organ was markedly enlarged and pulpy, almost diffuent frequently no change was apparent either in size, colour, or consistency.

4. Kidney.-

Usually healthy but slight congestion at the base of the pyramids. In other cases early cloudy swelling with albumen in the tubules and haemorrhage into some glomeruli.

6. The Liver.-

Generally enlarged and pale. On section there was distinct evidence of fatty degeneration, sometimes to an extreme degree.

The other abdominal viscera were examined but revealed no abnormality nor was any change detected in the glands. Favourable opportunity did not arise for the examination of the brain and meninges,

PROPHYLAXIS.

This subject opens up a wide field for discussion and in view of the prevailing heavy mortality from pulmonary complications following influenza there is little wonder that the question of prevention has assumed a new and national importance. At the present time influenza is still advancing and it must be confessed that so far medical science has failed to provide an adequate barrier to check its progress. A long list of hygienic recommendations has been issued under the authority of the Local Government Board but the measures suggested are but palliative and do not strike at the root of the evil. A more potent method of prevention is urgently needed and in view of the success of inoculation in controlling enteric outbreaks one naturally turns to vaccine as a prophylactic.

INOCULATION.

So far no official pronouncement has been made as to the value of vaccine in producing artificial immunity. Assuming that the delay is due to the non discovery of the real causative organism of influenza and the supposed impossibility therefore of preparing a suitable type of vaccine, are we justified in adopting the "Wait and See" policy in view of recent knowledge as to the important part played by the streptococcus and pneumococcus in causing pulmonary sequelae? So fully is this recognised that the term "septic pneumonia" is now commonly applied by medical

men to the pulmonary complications of influenza. Admitting that several types of these organisms exist and that each type possesses several strains, it is still possible by careful selection to prepare a potent vaccine, nor is such a method "a mere shot in the dark" as some authorities suggest. The composition of a standard vaccine is determined by experience of the types proved to be most dangerous in recent epidemics. These are not necessarily the same in different countries but may possess dissimilar characteristics as demonstrated by Lister in South Africa and the Rockefeller Institute in America. The degree of potency of the various types of pneumococci and streptococci have been recognised.

Referring to ^{pneumococcal} vaccination Rufus Cole states:-

"Animal experimentation now gives a rational basis for this procedure, at least as far as types i, ii, and iii, are concerned. The first important studies in this direction have been made by Lister in South Africa, where pneumonia among the natives working in the mines has for many years been a serious matter. He has now carried out preventive inoculation in a large number of men with striking and definite results. During the past winter, 1917-1918, Cecil and Austin, working at the Rockefeller Institute and Camp Upton have conducted investigations as to the best method of preparing vaccine, the proper dosage to employ and have vaccinated more than 12,000 soldiers. Although sufficient time has not yet elapsed to make the results

conclusive, it is of great significance that while a considerable number of cases of pneumonia have occurred among the uninoculated men in this camp, not a case of pneumonia due to types i, ii, or iii, has occurred among the inoculated men, the latter having received vaccine containing these types of pneumococci." There is therefore definite data at our disposal on which to take action and provide for the community a maximum of protection.

The efficacy of a suitable standard vaccine as a prophylactic has been further demonstrated by Captain Armitage, N.Z.M.C., and his remarks are as follows:-

"During the June epidemic so many cases of 'influenza' occurred in the staff that we had thirty-five orderlies in hospital at one time. Arrangements were immediately made to inoculate those who had not contracted the disease; the inoculations, however, were not compulsory.

"Although the total staff numbered 250 not another case occurred in the unit from that time. This appears at first to be evidence of effective inoculation, but the records show that only six individuals volunteered for the injection!

"At the end of October the epidemic had acquired so serious a nature that the whole of the staff was inoculated. Nine officers, fourteen sisters, and ninety-one other ranks were at once inoculated with the following vaccine:

"N.Z.E.F. Mixed Catarrhal Vaccine Prepared by
Captain Lowe and Dr. Eyre.

	<u>Dose 1</u>	<u>Dose 2</u>
Pneumococcus	50	100 million
Streptococcus	10	50 "
B.influenzae	10	30 "
Staphylococcus aureus	200	500 "
M.catarrhalis	25	75 "
B.pneumoniae	50	100 "
B.septus	50	100 "

"Meanwhile steps had been taken to prepare what was considered a more suitable vaccine.

"In order that as far as possible the vaccine should provide adequate protection against the prevalent infection of the particular place and period, it was decided:

"1. That the essential constituents were the Pneumococcus, Streptococcus, and B.influenzae.

"2. That it was of fundamental importance that the pneumococci should include Types I and II, and, in the light of the experience of Major Borel of the French Army, that it would be wise to add other types not included in those worked out by the Rockefeller Institute, but isolated from our fatal cases.

"3. That several virulent strains of B.influenzae and Streptococcus haemolyticus isolated from our fatal cases should be included.

"4. That it should be unsensitized and unheated.

"5. That primary or secondary subcultures only should be used.

"The vaccine was therefore prepared accordingly.

"Dosage.- Fearing to use the massive dosage of Lister in case of getting very severe reaction in a staff that could not be excused duty after inoculation, and not wishing to use what was thought to be the small dosage of the N.Z.E.F. vaccine, the following scheme of dosage was drawn up and carried out:

	<u>Dose 1</u>	<u>Dose 2</u>
B.influenzae (12 strains)	500	1,000 million
Pneumococcus (3 types)	250	500 "
Streptococcus haemolyticus (12 strains)	250	500 "

Interval seven to ten days.

"The total dosage is admittedly not as high as it might have been; it would have been safer to have given a third dose, but there are limits to what can be done in the way of inoculation in a busy hospital with a hard worked staff, and one must admit that all hands were "fed up" with the innumerable injections received during the last four years.

"One officer, 23 sisters, and 109 other ranks were inoculated with this vaccine. There were numerous cases of moderate local reactions and malaise, but none were sufficiently severe to cause anxiety or admission to hospital, in fact no one "reported sick".

"That relic of opsonic index days, the "negative phase," appears to be rather a bogey as far as prophylactic inoculations is concerned. The experience of the last four years indicates that when disease appears shortly after prophylactic inoculation it is more probably due to inappropriate vaccine or

inadequate dosage than to infection during the "negative phase".

"Of the 114 cases inoculated with the "N.Z.E.F. mixed catarrhal vaccine" supplied from London there were a few admitted to hospital with "influenza" or "Cold," but none were seriously ill and none developed pneumonia. Of the 133 cases inoculated with the vaccine prepared in the hospital laboratory there were no cases of either "influenza", "cold", or pneumonia. Considering that during the epidemic the hospital received hundreds of cases of "influenza" or pneumonia, it seems wonderful that the staff should have escaped. The inoculations certainly appear to have afforded protection, but the numbers are small and an important factor no doubt was the excellence of the supervision, the masking of attendants, and the high standard of sanitation and hygiene; for not only did no nurse or orderly in the pneumonia ward develop pneumonia, but in the whole of the seven months that the hospital was acting as the infectious disease hospital for the Second Army not a single attendant in the Infectious Block contracted any infectious disease."

The records showing the results of prophylactic inoculation in N.Z. camps and hospitals in the United Kingdom are not yet available but it is stated officially that the use of the Mixed Catarrhal Vaccine has been decidedly beneficial.

Further evidence of the success attending the use of vaccine as a prophylactic against pneumonia is recorded by Major Borel, Service de Sante, of the French Army, at a meeting of the Research Society of the American Red Cross in France on Sept. 7th. 1918. Speaking on "The Acute Respiratory Infections among the coloured troops in the French Army," he described the serious epidemics and heavy mortality experienced among the Senegalese, amounting in the case of one battalion to an incidence of 140 per cent and mortality of 33 per cent in eight weeks. He related the difficulties he had encountered in obtaining satisfactory immunisation with vaccines, and showed that it was not until the type of the infecting pneumococci had been determined and the appropriate vaccine used that success was obtained. Large, even, massive, doses appear to have been employed, the smallest being 2,000 millions pneumococci and a total dose given in three injections of 28,000 millions. He states that he had no reactions local or general and claims "a perfect result" from the inoculations.

The necessity of using only properly graded vaccine is referred to in the article by Cummings, Sprint and Lynch, in the Journal of the A.M.A. of Aug. 24th. 1918. They recommend the prophylactic use of a vaccine of streptococcus haemolyticus and pneumococcus Types I and II as a protection against complications incidental to scarlet fever as well as against the lung infections of streptococcus and

pneumococcus pneumoniae.

Rufus Cole in the same Journal states that after the prophylactic inoculations with vaccines of typed pneumococci not a single case of pneumonia due to types I, II, and III occurred among the inoculated men, while there were a considerable number of cases among the uninoculated. He concludes that prophylactic vaccination is of the greatest value.

The success of inoculation as a prophylactic measure is not confined to Europe and America but extends to the Dominions overseas. During the past four months both Australia and New Zealand have been visited by an epidemic of influenza with pulmonary complications which swept through both countries with extraordinary severity and caused a heavy mortality. The evidence from N.Z. as to the value of prophylactic inoculation is decidedly favourable and in an official cablegram from Sydney dated Feb. 23rd. it is stated that medical men were unanimous in reporting that persons who had been previously inoculated recover.

DOSAGE.

The vexed question of dosage in prophylaxis appears to be a stumbling block to progress in vaccine therapy and there is no doubt that its value has been largely discredited by the failures due to unsuitable dosage. On this point the opinion of Capt. Armitage, N.Z.M.C., is both interesting and instructive. He states:- "The basic principle of dosage is definite. No matter what the vaccine, the correct dosage can be

estimated from experience of what has proved effective after inoculation of large numbers of men against diseases such as typhoid and plague." "The dosage is based on the weight of the proteid matter of the organism and on this alone . Taking the weight of the correct dosage of typhoid vaccine (dosage 500 millions 1000 millions and 2000 millions) as the unit, the dosage of any other vaccine used in prophylaxis can be estimated from the relative weight of the other organism. If the B.influenza be one quarter the weight of the B.typhous the correct dosage of B. influenza would be four times the typhoid dose. The relative number per millegramme of the various bacteria used in vaccines have all been determined therefore no difficulty should arise in arriving at a suitable dosage."

The susceptibility of the patient is a factor which under ideal conditions should govern the dosage both in prophylaxis and treatment. In private practice this can be determined by inoculation and observation but it is not practicable in dealing with the multitude during an epidemic. In such cases the best method is to observe due caution and employ the largest dose compatible with safety, assuming that the toxicity of the vaccine is reduced to a minimum by the method of preparation. The amount of immunity conferred is the same whether given in 1, 2, or 3 doses, if divided the reaction is diminished.

The foregoing evidence tends to prove that prophylactic inoculation has passed beyond the experimental stage and has a distinct claim to official recognition. With few exceptions the medical profession have not taken it seriously either as to its advisability or efficiency, not has it yet been put upon a sound basis. Unfortunately many of the stock vaccines placed on the market were wrongly constructed and failed to produce the immunity claimed for them. There can, however, no longer be any doubt as to the protection afforded by a vaccine of the right nature and dose, and there is no reason why inoculation against pneumonia should not be as effective as that against enterica. It is now recognised that, like the enterica group of the typhoid and paratyphoids A and B, the pneumococci and streptococci also are of various types and that protection against each type can only be provided by the use of the homologous type. It must be admitted however that the duration of immunity appears to be much shorter in pneumonia than in enterica.

Objection has been raised as to the practicability of prophylactic inoculation on a large scale. This is a difficulty which could be readily overcome by proper organisation. The splendidly staffed and equipped Out Patient Departments of hospitals and Tuberculosis Dispensaries throughout the Kingdom could be utilized and but little extension of existing arrangements

would be required to meet all demands. To ensure successful results it would be necessary:-

1. To provide free inoculation with vaccine of known prophylactic value for all applying at the various centres. Inoculation should not be compulsory.

2. To keep complete records for comparison with the health statistics of the district especially with reference to notification and the mortality rate.

As showing the attitude of the Medical Department of the N.Z.E.F. as regards prophylaxis the following extracts from a Headquarters Memorandum of Feb.1st.1919 to all camps and hospitals is submitted:-

M.C.V.Inoculation.

From statistical authority it is suggested that it is not unlikely for an epidemic of influenza to appear in the United Kingdom in February or March. In order that the N.Z.E.F. may be well prepared for the same, several points will need attention:-

1. Officers and other ranks not feeling well should immediately report to the medical officer, who will order the necessary isolation without delay in the event of a definite diagnosis of influenza being made.
2. Where cases of influenza appear in a unit it is desirable that a thinning-out of the number of men in each hut be effected as early as possible. This will obviate the spray infection.
3. All those suffering from influenza, and the immediate contacts, should wear the ordinary gauze masks.
4. When men report at sick parade of the unit in

which influenza or colds are prevalent, it is advisable that arrangements be made whereby the men will not be kept in the open for too long a period, and that they be instructed to stand four feet apart. No time should be lost in dealing with these cases.

5. The very greatest care should be exercised, when evacuating to hospitals men suffering from influenza, to ensure that they will not be unduly exposed to cold air or draughts.

Dr.Eyre is of opinion that all those who, within the last three or four months, have had two doses of M.C.V. should not have a third dose of M.C.V.No.2. All who have not been inoculated with the M.C.V. should be inoculated immediately with Nos.1 and 2.

HYGIENIC MEASURES.

Infective respiratory diseases develop their most malignant form when the hygienic conditions are unfavourable and it has been abundantly proved in military camps that the incidence is increased by overcrowding of huts, defective ventilation, and neglect of personal hygiene. The greatest possible attention should therefore be paid to the details of sanitation. The value of effective ventilation has been experimentally proved by bacterial plate cultures in huts for it is found that the germ incidence is greatest near the floor and disappears at the lower level of the windows. This demonstrates the advisability of deep window frames with sashes opening above and below,

also the importance of placing beds sufficiently high to secure free and direct ventilation.

"CARRIERS"

Evidence strongly points to infection by direct transfer from a patient and there is every reason to believe that the infection starts in the nasopharynx and descends along the respiratory tract. Haemolytic streptococci have been found in the throats of healthy persons in addition to those who have recovered from the disease and the danger from "carriers" cannot therefore be over estimated especially in crowded buildings, trains, tramcars, etc. It is not practicable to detect and isolate healthy "carriers" but much may be done by education to minimise the spread of infection. The public should be repeatedly warned through the newspapers and by official pamphlets of the methods by which such infectious disease is spread, also that it constitutes a grave menace to the public health to expectorate or otherwise distribute secretions from the nose and mouth.

FACE MASKS.

The value of face masks as a preventative of infectious disease is not yet fully appreciated. The evidence however is strongly in favour of the efficacy of this measure especially when proper attention is also paid to the details of technique for the limitation of infection. So far all attempts at prophylaxis by ordinary hygienic measures have failed to check the spread of the epidemic simply because the necessity of controlling droplet infection has been overlooked.

When it is realized that coughing and sneezing or even talking by an infected host distributes the organisms for a considerable radius the value of 'masking' becomes obvious. Dr. H. Jocelyn Smyly, of the Union Medical College, Peking, writes:-

"I had experience during an epidemic of pneumonic plague in the province of Shansi, China. In this, the most infectious disease known, absolute protection can be obtained by the use of a proper face mask. This was amply proved during the Manchurian Epidemic some years ago and in the Shansi Plague Prevention Service not a single worker, foreign or Chinese, was infected. Pneumonia plague as was demonstrated by Strong in Manchuria, is carried by droplet infection when the patient coughs or even talks. The method employed to guard against it should be equally effective in other infectious diseases similarly conveyed such as influenza, diphtheria, scarletina etc. and ought certainly to be adopted by those in attendance in such cases."

The face mask most effective is prepared as follows:- A length of gauze, about 30 inches long and 9 inches broad is laid on a table; in the middle of the strip is laid a piece of cotton wool, not too thick, and cut 6 inches by 3 inches. The gauze is then folded longitudinally over the wool and cut lengthwise so as to make 3 tails from each end of the cotton pad. To apply the mask the cotton pad is placed over mouth and nose, the upper part of tails pass above and the lower pair below the ears and are tied behind the head, the

middle pair are tied over the vertex to prevent the mask slipping down.

At the 8th. Session of the Research Society of the American Red Cross in France, Lieut.Col. Capps read a paper on "The Sanitation and control of Infections of the Respiratory Tract." He stated that the wearing of face masks had been put on a sound clinical and experimental basis at the Durand Hospital for Infectious Diseases by Weaver (Journal of A.M.A. Jan.12th.1918) who for more than a year previous had protected his staff from diphtheria and scarlet fever. After masks were worn universally by patients and attendants, cross infections ceased and only 20 cases of broncho pneumonia occurred in over 900 cases of measles, although streptococcal infections were prevalent. To limit the spread of respiratory affections the author recommended the following measures:-

1. Avoid overcrowding.
2. Mask all respiratory cases as soon as recognised.
3. Mask all ambulance patients.
4. Separate patients beds by sheets.
5. Mask all surgeons, nurses, and attendants.
6. Sterilize eating utensils after each meal.
7. Disinfect masks in creasol and then boil in soap and water.
8. Finally, the time has come for the internist to take the same attitude towards respiratory infections that the surgeon has toward wound

infection and to develop a comprehensive technique for their limitation and prevention.

In Oct. 1918 the "Academic de Medicine" adopted a report of Dr. Besancon's on the prophylactic measures against influenza, which included the following recommendations:-

1. Avoid all contact with patients.
2. Antiseptic washes for mouth and naso pharynx.
3. Avoid all crowded places, especially dark and badly ventilated rooms, theatres and cinemas.
4. Insure effective and repeated disinfection of trams, busses, etc.
5. Isolate patients from each other and from visitors.
6. Use masks similar to those adopted by the Americans for all attendants and for patients themselves at the beginning of convalescence.

It is not suggested that "masking" during an epidemic should be universal for the carelessness regarding proper hygiene would be a fatal to success. All those however whose duties necessitate contact with cases of infective respiratory catarrhs should certainly be protected. Of equal or even greater importance is the "masking" of the patients except in special conditions, where it might embarrass respiration.

It is quite unnecessary to further supplement the various recommendations already advanced as prophylactic measures. The truth of the old adage "Prevention is better than cure" was never more evident

than at the present time when the people, stricken with an epidemic which is inflicting heavy loss among the flower of our manhood, naturally turns to the medical profession for a remedy. So far medical science has been tried and found wanting but in view of the success which has attended the preventative measures already advocated it is hoped that official conservatism will be set aside and immediate steps taken to provide the greatest possible immunity by inoculation throughout the country.

TREATMENT

No drug has yet proved to be a specific in the treatment of infective respiratory diseases. In our experience during the epidemics two points proved to be of importance in treatment:-

1. The avoidance of all antipyretics which tend to depress the heart;
2. The necessity of judicious stimulation in order to combat the depression from toxæmia which is so marked a feature of purulent bronchitis.

ROUTINE TREATMENT.

From the official report in the first epidemic it appears that no special line of treatment has definitely good results nor was the administration of oxygen, which appeared to be so strongly indicated in the rapid breathing and cyanosis, of more than temporary benefit. The earlier cases of the series were treated with stimulants expectorant mixture

stimulants such as Brandy, Strychnine, and Digitalis, a stimulant expectorant mixture, antiseptic inhalations, and oxygen either warmed or passed through warm alcohol.

VACCINES.

The latter cases were treated on admission with a stock vaccine of Pfeiffer's and Friedlander's bacilli and latterly with an antogenous vaccine prepared from selected cases of the series. Of 26 cases treated early with the mixed P. and F. vaccine 18 had a marked fall of temperature and some alleviation of the other symptoms following its use; but a few cases untreated by vaccine had a similar course. Of 11 cases treated later in their course with the autogenous vaccine only 5 showed results at all favourable.

In the second epidemic, in addition to ordinary treatment, an anti-streptococcus serum and also the M.C.V. was employed with, in the opinion of Captain Eagleton, R.A.M.C., satisfactory results. Col. McLean the O.C. hospital, was also satisfied that the vaccine had been distinctly useful.

In view of the difference of opinion as to the benefit of treatment by vaccine in the first and second epidemics it is interesting to quote the remarks of Capt. Armitage, N.Z.M.C. regarding the results during the epidemic in France. It should be borne in mind that nearly all the former cases were of the purulent bronchitis type, the latter were chiefly pneumonias:

"Vaccine Treatment of 'Influenza' and Pneumonia Cases"

"Nature of Vaccine Used.- The vaccine consisted of Pneumococcus and B.influenzae prepared from organisms isolated from the blood or lungs of the most toxic cases, six suitable strains of each being used. In the case of pneumococcus two strains of each of three types - mixed, sensitized, and unsensitized - the types I, II, and an inagglutinable type of Group IV. In certain cases of bronchopneumonia in which a Streptococcus haemolyticus was present, that organism was included in the vaccine in the same strength as the pneumococcus.

"Dosage.- The first dose used in each case of 'influenza' was 75 million pneumococci, consisting of 25 million of each of three types of Pneumococcus, and 100 million B.influenzae, and in the case of pneumonia 25 million of the three types of Pneumococcus and 100 million B.influenzae, and this was repeated or decreased in the next dose according to its effect in the particular case, and increased in later doses if necessary. These initial doses were maintained throughout in order to preserve some continuity of dosage, it being considered better to have results from 50 or 100 cases treated with the same initial doses than to dodge about from one dose to another.

"Intervals.- The temperature, pulse, respiration, and condition of lungs and heart were considered in deciding the intervals. No untoward results could be attributed to the dosage except in two cases of

pneumonia in which rigors occurred during the night following.

Vaccine Results.

"Total influenza cases during November	...	327
Cases with respiratory complications	...	132
Cases with pneumonia	...	40
Deaths	...	22

	Total Cases	Developed Pneumonia		Mortality per Cent. of Total Cases.
		No. of Cases	Deaths	
I. Inoculated against pneumonia immediately after onset of "Influenza. Not inoculated immediately after onset	10 317	0 50	0 27 - 54%	0 8.5
II. Inoculated immediately after onset of respiratory com- plications (but before pneu- monia). Not inoculated immediately after onset of respiratory complications	56 76	10 40	5 - 50% 22 - 55%	9 29
III. Inoculated only after pneu- monia supervened Not inoculated (pneumonia)	29 11	29 11	15 - 52% 7 - 63%	52 63

"As far as can be judged from the small number of cases, the prevention of pneumonia by vaccine inoculations was successful, whether carried out before or immediately after the onset of 'influenza', though it must be remembered that we were dealing with presumably sound and healthy individuals (apart from the attacks of 'influenza'), and that such uniformly satisfactory results might not be obtained with the average man and woman. It is noticeable that the mortality rate increased in proportion to the seriousness of the condition when the vaccine was first administered, that the earlier it was given the better the result, but that in the cases in which pneumonia occurred the mortality was about 50 to 60 per cent., whether vaccine was, or had been, administered or withheld. It is quite possible that better results might have been obtained under conditions in which more attention could have been paid to individual cases than is possible in a crowded field hospital, or even with a different vaccine dosage or interval; but, as far as pneumonia is concerned, our results pointed to the success of vaccine in prevention, but to a very doubtful benefit in treatment once pneumonia was established. Unfortunately no antipneumococcus serum was available for treatment."

From the foregoing experience of N.Z. medical officers both in England and France it would appear that the success of vaccine treatment depends upon

early inoculation. The best results are seen in cases where treatment is begun immediately the symptoms of "influenza" develop, the longer it is delayed the less chance is there of a beneficial effect.

Some uncertainty exists as to whether vaccine or serum should be given. Expert opinion favours vaccine in "influenza" for the following reasons:-

1. Vaccine reduces the incidence of pneumonia.
2. The serum is a pneumococcus antitoxin and is specially devised to neutralize the endotoxins circulating in the body. There is no evidence that any such endotoxins exist in influenza.
3. The effect of the antitoxin (or serum) is transient, it ~~exerts~~ its effect, is excreted within a comparatively short time and does not induce the formation of antibodies in the patient. The antitoxin should therefore only be used when there is specific work for it to do, e.g. when a state of pneumonia exists.
4. Only a proportion (amount variable and unknown as to English cases) of pneumonias are due to type I pneumococcus and the only pneumococcus serum that has proved effective is type I. It should therefore be administered only in cases proved to be infections with type I pneumococcus or in case of emergency pending the necessary examination of the blood or sputum. If employed it should be with the reservation that it may not be appropriate and that its failure is to be expected should the case prove to be due to a pneumococcus of types II, III or Group IV.

On the various types of pneumonia some interesting remarks occur in a monograph of the Rockefeller Institute for Medical Research, Oct. 16th. 1917:-

"Pneumococci of types I and II are responsible for about 64 per cent of all cases of lobar pneumonia and are of relatively high virulence for man, the largest number of deaths in lobar pneumonia being due to these organisms. The mortality in type I infection is 25 per cent and in infections with type II pneumococcus about 32 per cent. These two types together are responsible for approximately 62 per cent of all deaths from lobar pneumonia."

"We now know from experiments on animals that an anti-pneumococcic serum is only protection and curative provided it is employed to combat an infection due to the same type of organism as that used in its production. We also know that to cure after infection has once occurred, the serum must be employed in very large amounts, and preferably injected intravenously."

These attempts have resulted in the demonstration that anti-pneumococcic serum, prepared by the injection of type I pneumococcus is highly effective in the treatment of cases of pneumonia due to the same type of organism. The serum of type II is much less efficacious, indeed it has not yet been thoroughly demonstrated whether it has any practical effect in the disease or not. Immune serum may be prepared by the injection of type III pneumococci and this serum has slight agglutinating power and slight protective

power for animals. This power however, is so slight that the therapeutic application of this serum has not been considered promising or justifiable. From what has previously been stated it would be impossible to prepare a serum which would be effective against any considerable number of cases of infection due to type IV pneumococci."

"As soon as the type of pneumococcus responsible for the infection has been determined, if it proves to be type I, serum treatment should be undertaken at once in all cases, except in very young children who appear but little intoxicated by the infection and in whom the prognosis is good and the difficulty of treatment great."

"The final test of the effectiveness of serum must rest on the evidence concerning the saving of lives. The cases so far treated in the Hospital of the Rockefeller Institute is not large but they indicate almost certainly that the serum as employed by us has a marked curative effect in the treatment of pneumonia of type I. Up to the present time 107 cases of lobar pneumonia of this type have been treated with serum and of these but 8 have died, 7.5 per cent. When this is contrasted with the mortality of 25 to 30 per cent, as observed in our cases before we commenced serum treatment and in the case observed elsewhere, the results obtained are definite and striking. In the fatal cases we have included every patient that received serum, even a single dose." (Avery, Chickering, Cole, and Dochez.).

An important point on type determination appears in a Bulletin on Transmissible Diseases published by the American Red Cross in France, May 1918. It states:-
"If a type I organism be found, a skin test for hypersensitiveness to horse serum should be done before serum is administered. Serum should never be administered unless type determination can be made. It is only in type I cases that serum has been found useful, and to give serum in other type infections not only wastes the serum but uselessly renders the patient hypersensitive to future injections of horse serum."

CONCLUSION.

In reviewing the results of treatment one must confess to a feeling of disappointment that so little success has been achieved. So far the various forms of infective respiratory catarrh prominent throughout the epidemics and especially purulent bronchitis have failed to respond to the measures adopted, more particularly when the disease is in an advanced stage. Prevention therefore is the sheet anchor on which to rely; it is infinitely preferable, and has certainly proved to be better than cure. There is ample evidence that the high mortality is due to pulmonary complications but the virulence of the causative organisms has been greatly increased by an attack of Influenza or other acute antecedent disease. Properly organised and sustained effort should therefore be directed towards checking the spread of these diseases for in

this direction only can we hope to avert the dire results of the pulmonary sequelae.

- - -

General Notes compiled from official sources on the
Epidemic at the New Zealand Camp, Sling,
Salisbury Plain, in January and February,
1918, among recent reinforcements of
New Zealand troops.

HISTORY.

Two reinforcements of N.Z. troops were concerned viz.- 31st. and 32nd. These men were conveyed from New Zealand in three transports leaving on Nov.21st. 1917, passing through the Panama Canal and arriving at Newport News in North America on Dec.18th. They left this port on Dec.23rd. arriving in Liverpool on Jan.7th.1918, and Sling Camp a day or two later. The troops landed at Newport News and there seems to be no doubt but that the infection of morbilli and rubella was contracted at that place, for cases of measles of one type or other occurred in each ship between Jan.5th. and 8th. These cases were evacuated to hospital at Liverpool.

From Jan.8th. onwards large numbers of both types of measles were admitted to the District Isolation Hospital at Brimstone Bottom until all accommodation being filled it was found necessary to open "J" Block of the Military Hospital, Tidworth, and later still "E" Block of the same hospital.

MORTALITY.

Many of the patients arrived in hospital in a very serious condition necessitating their being placed on the "Seriously Ill" list on admission.

There were in all 75 cases complicated by the disease termed "Purulent Bronchitis". This, as will be seen by the notes, is really a septicaemic pneumonia of a most malignant type. Twenty-seven of these cases died giving the high rate of 36 per cent. The cases are dealt with under Parts 1 and 2, the former including patients admitted to Brimstone Bottom Hospital from 20-1-18 to 22-2-18, the latter to Tidworth Hospital from 22-2-18 to 13-3-18.

PART I

1. Total admissions were 433, of these 321 occurred among New Zealanders at Sling and 112 among other troops.

Of the 321 New Zealanders, 95 had measles, 225 had rubella and 1 scarlet fever. Of the 112 "other troops" 10 had measles, 101 rubella and 1 scarlet fever.

2. The largest number of admissions in one day among New Zealanders was 36 on 26-1-18, viz. 5 for measles and 31 for rubella.

3. The total number of cases in which purulent bronchitis developed was 61, which all occurred among New Zealanders, none among other troops, giving a percentage of 19.0 per cent of New Zealanders admitted.

Of the 61 cases, 45 were associated with

measles, 8 with rubella, 7 with mixed measles and rubella and 1 with scarlet fever. The first case of purulent bronchitis was observed on 31-1-18 in a man who had been admitted on 10-1-18 for rubella; it was severe and typical but this man recovered.

4. Deaths.- 26 deaths occurred among the 61 cases of purulent bronchitis, giving a percentage of 42.6 per cent for cases which developed this complication.

5. Bacteriological investigation of the cases of purulent bronchitis showed a mixed infection with pneumococcus, staphylococcus, etc. and in some cases the B. influenza was isolated. Post mortem results showed constant presence of streptococci.

REMARKS.

The fatal cases of purulent bronchitis developed a marked toxæmia and several showed a septicaemia rash. It was noted that in several cases a mixed infection appeared to exist and that a definite line of distinction could not be drawn between cases of measles and rubella. The virulent type of infection among New Zealanders is an outstanding feature of this outbreak.

PART II.

1. Total admissions were 121, of these 95 cases occurred among New Zealanders and 26 among 'other troops'. The 95 cases included 79 men from a newly arrived contingent of New Zealanders stationed at Larkhill, the remaining 16 cases being admitted from

Sling.

2. Purulent bronchitis arose in 14 cases. Of these (a) 13 were among New Zealanders, all being associated with measles, giving a percentage of 13.68 per cent of the admissions for New Zealand troops; (b) 1 case occurred in a man of the A.S.C., M.T., admitted from Larkhill for measles. This man four weeks previously was admitted for rubella into Brimstone Bottom Isolation Hospital, and had been employed in driving patients from Sling to that hospital. This was the only case among admissions for other troops in which purulent bronchitis developed.

3. Deaths.- 1 death occurred from purulent bronchitis in a New Zealander admitted from Sling for measles, giving a percentage of 7.7 for cases developing this complication.

It was noticed that the type of disease in cases admitted from Larkhill was as a rule, of a much milder type than in those admitted from Sling Camp.

SUMMARY.

Combining the two series of cases referred to in Parts I and II we obtain the following conclusions:-

1. Total number of admissions for
New Zealanders ... 410
2. Total cases of purulent bronchitis
among New Zealanders ... 24
including all troops ... 75
3. Percentage of purulent bronchitis
among admissions for New Zealanders 18 per cent
Including all troops ... 13.5 "

4. Total deaths among New Zealanders (all among cases developing purulent bronchitis)	... 27
Percentage of cases showing this complication	... 36.2
Total percentage for all troops, including 1 death among 'other troops'.	... 36

REMARKS.

Of the 27 cases terminating fatally, the majority of the men were between the ages of 20 and 30, only 4 being older than 30. The complication which was implanted in the measles appeared to be an infection of the respiratory tract, accompanied by toxæmia. In the severe cases the blood infection of the respiratory tract varied, sometimes preceding, sometimes coincident with and sometimes following the onset of symptoms of measles and afforded no criterion of the severity of the case.

The history of three typical cases may prove of interest:-

59638 Pte.Griffen J. Canterbury Regiment N.Z. (Age 22)

History:- Had a cold for some time previously. Only felt ill on 15-2-18. Rash appeared on 17-2-18. Admitted Brimstone Bottom 17-2-18.

State on admission:- Looks ill. Dusky cyanosed congestion of face. Breathing laboured and rapid. Aphonic.
RASH. A macular raised rash on face and trunk.
TEMPERATURE. 104.2.
PULSE. 142 poor in volume and tension.
RESPIRATION. 40.
TONGUE. Dry and covered with yellowish fur.
FAUCES. Dry and covered with mucus.
HEART. No adventitious sounds.
LUNGS. Both full of wheezing rhonchi with moist rales at bases. Air entry as judged by sounds poor at apex of right lung. Breath sounds harsh at right base.

SPUTUM. Nummular, purulent and airless.

COURSE 18-2-18.

FACE very congested and cyanosed.

TEMPERATURE 99

PULSE 108

RESPIRATION 40

LUNGS. As above with a few crepitations at left base and impairment of percussion note. A dose of mixed Pfeiffer and Friedlanders bacillus vaccine given in doses of 300 million Pfeiffer and 60 Friedlander.

22-2-18. From the 18th. onwards the lung condition was a progressive one to a general broncho-pneumonia of both lungs.

TEMPERATURE. Had a regular evening rise.

PULSE: Was poor in volume and tension throughout.

RESPIRATION: Were rapid throughout at one time reaching 54 per minute.

During the last 24 hours sputum was not expectorated in any great quantity owing probably to lack of strength.

Patient died at 9-45 p.m.

TREATMENT. Besides the single dose of vaccine treatment was confined to Brandy, Strychnine, Digitalis and Oxygen.

41740 Pte. Cooper A.C. Wellington Regiment N.Z. (Age 26)

HISTORY. Had been feeling unwell for 4 days. Thought he had influenza. Previous to this had a cough for some time. Reported sick on 20-2-18. Rash came out same day. Admitted Brimstone Bottom 21-2-18.

STATE ON ADMISSION. Looks seriously ill. Face congested and cyanotic. Breathing rapid and distressed. Disphonic.

RASH. A typical profuse measles rash on face, chest and arms and to a less extent on thighs.

TEMPERATURE 104.

PULSE 120. High tension.

RESPIRATION 32.

TONGUE. Dry and furred.

FAUCES Inflamed but clean.

HEART Nil.

LUNGS. Right side has widely distributed rhonchi and a few crepitations at base. L. side has a few scattered wheezing rhonchi.

SPUTUM. Purulent, yellowish and airless.

COURSE 23-2-18. Cyanosis deeper. Some delirium. Tendon twitching.

TEMPERATURE 102.

PULSE 104.

RESPIRATION 42.

LUNGS. Some crepitations and slight impairment of percussion note at left base. Given vaccine 25 million Streptococcus. Lanceolatus & 25 million Streptococcus. Pyogenes longus.

24-2-18. General condition better. Cyanosis still deep.

TEMPERATURE 98.4

PULSE 92

RESPIRATION 36

LUNGS Condition unchanged.

26-2-18 LUNGS. Show signs of consolidation at both bases. Air entry poor. Patient is now aphonic. Breathing very distressed and unrelieved by Oxygen. Sputum copious.

27-2-18. General condition bad. Cyanosis very deep. Very restless though mind clear. Bronchial breathing at both bases. Patient dry cupped over chest.

28-2-18. Condition worse. Sputum scanty. Lungs full of bubbling sounds. Died at 8-30 p.m.

TREATMENT. Was stimulant throughout. Brandy, Strychnine, Champagne, Digitalis and oxygen passed through warm alcohol.

63574 Pte. Dillon J. Otago Regiment N.Z. (Age 35)

HISTORY. Two days ago fainted on parade. Had been feeling fairly well previously. Rash appeared 14-2-18. Admitted Brimstone Bottom 14-2-18.

STATE ON ADMISSION. Looks ill. Face congested and cyanotic. Cough and Coryza. Breathing rapid and slightly laboured. Disphonic. Rash. Typical measles rash on face and upper part of chest and back.

TEMPERATURE 101.2.

PULSE 88

RESPIRATION 24.

TONGUE Dry and coated.

FAUCES Inflamed.

HEART Nil

LUNGS Some rhonchi at right base.

SPUTUM Nummular, greenish yellow & purulent.

COURSE. 16-2-18. Still cyanosed. Aphonic.

TEMPERATURE 102.4

PULSE 96

RESPIRATION 28

LUNG signs unchanged.

Given vaccine 300 million Pfeiffers
Bacillus and 60 million Freidlanders
pneumo bacillus.

18-2-18. General condition unchanged. Still
cyanosed.

TEMPERATURE 103.

PULSE 124 good volume and tension.

RESPIRATION 40.

In lungs wheezing rhonchi and moist rales
are widely distributed.

19-2-18. General condition better. Cyanosis
less.

Lung signs unchanged except for some
crepitations at right base.

20-2-18. Condition about the same. Sputum more
copious but nummular and purulent.

Given a second similar dose of vaccine.

27-2-18. From 21-2-18 progress was good and
lungs slowly clearing up, colour improving
cyanosis disappearing and sputum becoming
frothy. In right lung some creaking sounds
at apex and some crepitations at base.

3-3-18. Patient got up.

9-3-18. Lungs clear of adventitious sounds.
Sputum mucoid and only tinged with pus.

18-3-18. Patient was transferred to convales-
cent Hospital.

TREATMENT. Apart from vaccine, treatment was stimulant
Brandy, Strychnine and Oxygen.

BACTERIOLOGICAL REPORT.

Reference has already been made to the general
pathological conditions based on 14 autopsies but
special mention is here advisable regarding the lungs
and bronchi. A report from Capt. P. Bruce White,
Pathologist, District Laboratory, in the Bacteriology
Histology and Pathogenicity of the organisms isolated
is given in its entirety, also his conclusions,
analysis of findings at 14 autopsies and Table of
Differential Blood Counts in 7.

1. Plueræe.- In the great majority of cases a greater or lesser degree of fibrinous or serofibrinous pleurisy was found; in three cases the adhesions were very extensive.

As a rule there was very little accumulation of fluid. The condition was usually more marked on the right side.

2. Lungs and Bronchi.- The conditions of the lungs varied considerably from case to case, the differences being apparently a series of phases in the course of the disease.

All gradations were met with between typical purulent bronchitis with slight basal broncho-pneumonia and lungs which had advanced to complete lobar consolidation.

In lungs which had run their full course the following conditions could usually be discovered to occur in basifugal succession.

1. A basal consolidation (s.g. 1)
2. A zone of slightly aerated lung intermediate between lobar and broncho pneumonia (s.g. slightly 1)
3. A belt of broncho pneumonia (s.g. 1)
4. A belt in which minute elements of consolidation around the bronchi were closely dotted over the congested and aedematous lung.
5. An upper region of simple bronchitis.

This series must be qualified by the statement that in a few cases apical consolidations were found and that the anterior margins of the lungs and the small middle lobe of the right side were relatively unaffected.

In most cases the state of the right lung was

more advanced than that of the left.

A very constant feature of these cases was the appearance of petechae on the lung surface usually most marked towards the base and along the interlobar fissures. Blebs of interstitial emphysema and haematomata were encountered from time to time and in one case abscess formation was noted in the consolidated lower lobes.

The bronchi ~~were~~ in all cases acutely inflamed. The secretion varied considerably from case to case. In most cases a yellow purulent discharge occupied the lumina which poured from the larger bronchi when they were severed; at other times the bronchi contained a chocolate coloured froth interrupted here and there by the plugs of yellow pud.

The bronchial glands were uniformly enlarged.

3. The Heart. - At many of the autopsies marked sero-fibrinous perocarditis was encountered. As a rule the effusion was considerable, rendering the sac turbid. It was usually faintly turbid or flaked with fibrin. Fibrinous patches developed most frequently on the anterior apex and around the base.

In several cases the right heart was markedly dilated and was usually found to be gorged with clot. Apart from certain minute thickenings of the Aortic wall sometimes situated just above the semi-lunar valves the heart was found otherwise normal.

4. The Spleen.- While enlarged and pulpy spleens have been encountered at several autopsies it must be admitted that as a rule this organ has been fairly normal in size and consistency showing at most a slight tendency to become flattened. In view of the bacteriological facts to be discussed below this is somewhat remarkable.
5. No other important abnormalities were discussed.

Bacteriology.

In the investigation of the organism associated with the condition three main sources of information were exploited viz:- the sputum, the blood of the living patient, and the blood, spleen, effusions and discharges found at post-mortem examinations.

These will be treated of in sequence.

1. The Sputum.

Examinations of specimens of sputum gave diverse results. The organisms were most frequently encountered were as follows:-

Streptococcaceae. Strept. Pyogenes longus

A streptococcus brevis.

A 'green' streptococcus.

Strept. lancolatus (Pneumococcus).

Staphylococci.- Pyogenes aureus

Pyogenes albus.

Influenza Bacillus.

Among other organisms less frequently met with, were micrococci catarrhatis, B.fusiformia, diphtheroid bacilli and Diplococcus crassus.

The main problem which presented itself was the analysis of the various streptococcal types appearing in cultures.

On the whole it may be stated that the most constant organisms of the sputum were two varieties of streptococci.

(a) A streptococcus longus growing in a small discrete colonies and producing active haemolysis on blood agar.

(b) A streptococcus usually assuming a diplococcoid or brevis form. This grew in flattened colonies spreading at the margin and showing a tendency to coalesce into a 'greasy' looking greenish grey film when densely sown. Their haemolytic action was small and on blood medium they were found to be surrounded by a faint greenish hale.

Although 'Gram positive' diplococci with a fermentative action on inulin were on several occasions isolated from the sputum it became evident that the pneumococcus was not one of the prevailing organisms in the condition.

This was borne home by many failures where

preliminary cultural and microscopical features has been suggestive.

As regards the staphylococci, *Staphylococcus aureus* was of very frequent appearance in cultures, often being one of the predominating organisms of the sputal flora.

The case of the Influenza bacillus is more difficult to deal with. It has been found by us in a considerable percentage of sputa and probably has passed undetected in other. At times this organism appeared in large numbers, at others it was sparsely distributed.

In several cases however, where every effort was made for its detection, results were negative.

2. Blood cultures. - After careful examination of the organism isolated from the blood the conclusion has been reached that streptococci are almost exclusively present.

In one case only was the presence of the pneumococcus demonstrated with any degree of certainty.

The streptococci seem to coincide with the two forms described as most uniformly occurring in the sputa.

3. Post Mortem Cultures. - Cultures made from the bronchial secretions showed the same disparity as the sputa. The majority were typically streptococcal. In many *staphylococcus aureus* was obtained.

In one case only was *B. influenza* successfully

isolated in pure culture though smears of the secretions were sometimes suspicious. On the other hand this organism could not be found either in smears or cultures made soon after death in certain carefully studied cases.

Cultures from the blood, spleen, and pericardial fluid yielded uniformly a mixed growth of streptococci of the types previously described. Sometimes one variety appeared to predominate sometimes the other.

Inulin fermenting organisms of the pneumococcus type could be shown in two cases only. In two cases staphylococcus aureus was encountered in the pericardial fluid.

Histology.

Up to the present the histological changes in the lung have not been extensively studied. Such sections as have been examined show the transition of bronchitis into the condition in which the alveoli are involved. They show acute congestion of the walls of the bronchi and oedema and congestion of the lungs. Around the bronchi lie small areas of consolidation which merge in patches as the disease progresses.

The bronchial lumina are charged with cell debris in which abundant organisms can be seen.

The Blood Count.- Like the spleen the leucocyte count has proved one of the enigmas of the investigation. In place of the marked leucocytosis to be

expected in the presence of a bacteriemia it seems that the typical count lies about 10,000 per c.m.m.

On the whole the differential count registered the septicaemia more definitely though the relative polymorphonuclear leucocytosis appears below what might be reasonably anticipated.

A series of counts are given in the appended tables.

Pathogenicity of the organisms isolated.

The study of the pathogenicity of the organisms associated with the disease has been mainly restricted to those isolated from the blood and organs at autopsy.

Streptococci from the spleen, perocardial fluid and blood have been shown lethal to mice in moderate doses. In the case of both the Streptococcal types mentioned above death occurred 4-6 days after injection. The organisms were recovered from the blood and organs after death and were found in abundance at the point of infection, where an accumulation of pus occurred.

On several occasions an attempt was made to demonstrate the pneumococcus by injection into mice. Either results were negative or the suspicious organism proved to be a streptococcus.

Relationship of the organisms to the Condition.

In the presence of the somewhat complex factors by which the disease appears to be conditioned the question of its causation must be approached with some caution.

The outstanding features of the epidemic are from this point of view, the universal combination of Measles and a streptococcal septicaemia.

Whether there is a direct symbiotic relationship between the virus of measles and the streptococcus, lowering the resistance of the host and enhancing the virulence of the streptococcus, or whether the symbiosis is an indirect one through the medium of a third organism, the Influenza Bacillus is a question not altogether settled.

Personally I incline towards the former theory.

The Influenza Bacillus certainly appears frequently in the lung discharges of these cases but there is I think strong evidence against its universality.

With a view to gaining a rough idea of the prevalence of this organism in cases of influenza among the New Zealand troops at Sling a number of sputa were examined. In these the influenza bacillus was found in about 40 per cent; all the sputa were typically streptococcal.

Granting to B.influenzae the position accorded to it in other epidemics of Purulent Bronchitis it seems strange that out of 303 cases of clinical Influenza among the New Zealand troops in the same area in a large percentage of which B.influenzae must have been present no Purulent Bronchitis appeared.

In view of the streptococcal infection typical of these cases as contrasted with the pneumococcal

invasion described in other epidemics it is evident that Purulent Bronchitis is to be regarded as a clinical rather than bacteriological entity.

Conclusions.

1. The lung passes through a series of phases from Purulent Bronchitis to Lobar pneumonia. Intermediate is a condition in which consolidation takes place along the bronchial tree. This somewhat characteristic stage is followed by fusion of these elementary consolidations in broncho-pneumonic patches.
2. Pleurisy and Pericarditis are frequent complications.
3. The spleen shows relatively small signs of inflammation.
4. The essential infection is streptococcal. The pathogenic streptococci belong to two distinct types which usually appear together in the bronchi, blood, and spleen.

The pathogenicity of both of these organisms for mice has been established.

The Pneumococcus has been identified in relatively few cases and its virulence has never been established.

Staphylococcus aureus must add in many cases to the acuteness of the pulmonary attack but seldom invades the system.

5. B.influenza may or may not be found in the bronchial secretions. It is probably of individual rather than universal importance.

It seems reasonable to suppose that the virus of Measles plays a role of lowering the body resistance accorded to the Influenza bacillus in other epidemics.

6. No organisms of the Meningococcal type have been encountered. In my opinion the normal state of the adrenal glands strongly refutes suggestions of a meningococcal infection or Typhus.

7. The total leucocyte count is typically low (10,000); the differential 'white cell' count shows a slight relative polymorphonuclear leucocytosis.

ANALYSIS OF FINDINGS AT 14 AUTOPDIES

	Per 14	% (to nearest integer). &
<u>LUNGS.</u> Purulent Bronchitis and trace of Broncho pneumonia	3	21
Purulent Bronchitis and advanced Broncho pneumonia	5	36.
Pur. Bronchitis, Broncho Pneumonia, Lob. Pneumonia	6	43.
<u>PLEURISY</u>	12	86
<u>PERICARDITIS</u>	6	43
<u>DILATED HEART</u>	5	36
<u>SPLEEN.</u> Enlarged Pulpy	4	29
Approx. Normal	8	57
Fibrotic (slightly)	2	14.

TABLE OF DIFFERENTIAL BLOOD COUNTS ON 7 CASES.

	Pte. Mapp.	Pte. Gillies.	Pte. Thompson.	Pte. Dillon.	Pte. Wright.	Pte. Vining.	Pte. Ardrab.	
	78	81	83	74	77	69	75)
Polymorphonuclears	-	-	-	.5	-	-	-)
Eosinophiles	-	-	-	-	-	-	-)
Basophiles	-	-	-	-	-	-	-)
Large Mononuclears	1	1.5	-	2	3	3.5	3)
Large Lymphocytes	2	2.5	1	1	2	2.5	2)
Small Lymphocytes	19	15	16	22.5	18	25	20)
Termination.	Died	Died.	Died.	Rec.	Rec.	Rec.	Rec.	

General notes on Epidemic No.2 which developed on board the troopship "Tahiti" during the voyage from New Zealand.

The circumstances have already been related of the arrival of the "Tahiti" at Freetown, Sierra Leone, on August 28th. 1918, the contact with a ship infected with virulent Influenza and the subsequent development of the disease in the N.Z. transport.

The "Tahiti" left Wellington on July 10th. carrying N.Z. reinforcements consisting of:-

21	Officers
1080	Other Ranks
<u>10</u>	Nursing Sisters.
<u>1111</u>	Total.

The voyage was uneventful until Aug.26th.1918, when the first cases of the severe epidemic occurred. The ports of call were:-

Albany	-	Arrived	21-7-18;	Departed	23-7-18
Cape Town	-	"	9-8-18;	"	11-8-18
Sierra Leone	-	"	24-8-18;	"	26-8-18.

Shore leave was given at Albany and Cape Town but not at Sierra Leone. No cargo or food stuffs were taken on board at Sierra Leone.

On Aug.26th. the day on which the vessel left Sierra Leone, 12 men reported sick and were diagnosed Influenza. There has been odd cases of colds and a few others resembling mild Influenza after leaving N.Z. They were usually treated with good result by exposure to a zinc sulphate disinfecting vapour in the chamber

fitted up on the vessel. The "Tahiti" arrived with a clean bill of health.

On Aug.27th. 35 further cases occurred.

On Aug.28th. about 250 more men reported sick and by evening some 500 were down with the disease.

On Aug.29th. 800 men were under treatment.

On Aug.30th. many had recovered and the number under treatment was reduced to 500. Others developed bronchitis or broncho pneumonia and were in a septicaemic condition.

On Sept.1st.1918 the first death was reported.

"	"	2nd.	"	5	deaths	occurred.
"	"	3rd.	"	5	"	"
"	"	4th.	"	20	"	"
"	"	5th.	"	17	"	"
"	"	6th.	"	6	"	"
"	"	7th.	"	9	"	"
"	"	8th.	"	2	"	"
"	"	9th.	"	2	"	"
"	"	10th.	"	1	"	"

The ship arrived at Plymouth on 10-9-18 and went alongside the Keyham Dock. In all 68 deaths occurred and included 5 of the ship's crew, most of whom were attacked by the disease. The "Tahiti" disembarked her troops on Sept.11th. as follows:-

4 acutely ill cases to 2nd. Southern General Hospital, Plymouth;

110 sick men to N.Z. Military Hospital, Codford, the remainder by special train to Larkhill, Salisbury Plain, where a camp had been prepared and arrangements made to space out the men so that not more than 20 would occupy one 60 x 20 ft. hut. They remained segregated for a full isolation period. The 10 nursing sisters proceeded to Codford where special accommodation

was provided.

Clinical Features.

The following is an extract from the Voyage Report of the M.O. in charge of troops of H.M.T. "Tahiti":-

"The symptoms of the first stage of the disease were headache and malaise with rigors and rising temperature. After 12 hours the temperature ranged from 102 to 105 with headache, severe pains all over the body and profound prostration. Speaking generally, the first cases did not go beyond this stage which lasted 3-4 days. The temperature was then normal or nearly so with, in a few cases, a bronchitis, and in all, great weakness. Succeeding cases, commencing with some of Aug. 28th. showed symptoms of severe toxæmia with delirium, epistaxis, sordes, thickly coated tongue, sometimes vomiting, sometimes diarrhoea, and in two cases pronounced jaundice. In this series the temperature frequently rose to 104-105 but the usual was 102, 103. After 2, 3, or 4 days many of the toxæmic symptoms subsided leaving, in many cases, a severe bronchitis and in a few instances a broncho pneumonia. Symptoms of severe collapse showed up in some cases of this series and in some of the earlier cases whose temperature had not dropped to normal. The collapsed patients exhibited cyanosis, dyspnoea and rapid feeble pulse. At first most of these cases died but later many of them improved with remedial measures. The immediate cause of death in all cases was respiratory and cardiac failure due to

the unusual severity of the toxæmia and in some cases to a super-added broncho pneumonia."

The men who were seriously ill when disembarked were typical cases of purulent bronchitis, others showed a septicaemic condition, some of the milder cases appeared to be uncomplicated influenza.

The autopsies on cases dying at Plymouth confirmed the diagnosis of purulent bronchitis and it was found that death was due to setpicaemia associated with this condition.

At the Board of Enquiry, the Consulting Physician, N.Z.E.F. (Lieut.Colonel Macdonald) have evidence as follows:-

"The epidemic was one of purulent bronchitis very similar in character to that at Sling in February of this year. The sputum was purulent in about 65 per cent of the cases at Codford. Many had laryngitis with aphonia and the serious cases presented the same features of marked cyanosis, depression and severe toxæmia. The germs isolated were B.influenza, streptococci, staphylococci and pneumococci. Streptococci were grown from the blood in viro in all three cases in which they were sought. Purulent bronchitis is due to a double infection by the B.influenza and one or more of the germs which cause blood poisoning. The death rate in this epidemic was about 6 per cent as compared with 7 per cent at Sling. The infection was evidently carried in some way from the s.s. "Mantua" which was lying in Sierra Leone harbour when the

"Tahiti" arrived and cases were dying of "influenza" on the "Mantua". The health of the men in the transport was good until arrival at Sierra Leone."

Capt. B. Bruce Low, R.A.M.C., was detailed by the War Office to inquire into the outbreak and his report states:-

"The result of my inquiries showed that the disease prevalent on the "Tahiti" was Influenza, which in many instances was followed by bronchitis and broncho pneumonia. The type of bronchitis was similar to the purulent type which appeared among New Zealand and other troops on Salisbury Plain last winter and which is characterised by the occurrence of a septicaemia, frequently resulting in a fatal issue."

"Recommendations.

"1. The provision on transports carrying troops to Europe who are peculiarly susceptible to purulent bronchitis, i.e. New Zealanders, etc., of a prophylactic vaccine against this disease whilst influenza is prevalent in Europe. The vaccination could be carried out amongst all on board, when influenza appeared in epidemic form. I am told that a vaccine of this kind has been used with success amongst N.Z. troops at the time purulent bronchitis appeared recently on Salisbury Plain.

"2. The provision of steam spraying rooms for nasopharangeal disinfection on all transports carrying troops to Europe."

The summary of two cases, Private Saville and Private McAnteer, both of whom died, will illustrate briefly the clinical features and morbid anatomy of the type of disease prevailing throughout the 2nd. epidemic. In all respects the condition is similar to that of the 1st. epidemic. Sputa selected from five of the severer cases were examined. In all B.influenza was present in greater or smaller numbers, associated with Pneumococci and Streptococci so that the bacteriological picture is identical with that in the previously mentioned epidemic.

Capt. Eagleton, R.A.M.C., who was detailed for duty as bacteriologist at Codford Hospital states:- "B.influenza was present in 90 per cent of the sputa, streptococci were present in all and pneumococci and staphylococcus aureus in about 50 per cent of the remaining cases."

Capt. Pethybridge, R.A.M.C., Pathologist in charge of the laboratory at Devonport, stated that his examination of 15 sputa gave influenza like bacilli, not completely identified, in the majority associated with streptococcus longus and pneumococcus, whilst of the five post mortems that he had performed in men from the "Tahiti" B.influenza was present in five associated, in each case with pneumococcus and streptococcus longus.

Mortality.

The number of deaths occurring throughout the 2nd. epidemic were:-

On board "Tahiti"	68
At hospitals in England	9
Total	<u>77</u>

(COPY)

ARMY FORM A.27.

No.3, N.Z. General Hospital,
CODFORD, Wilts.
15th.Sept.1918.

REPORT OF DEATH.

73523, Pte. SAVILLE, John George. E/Coy.40 Reinf. NZEF.

Aged 31. Religion - Church of England

Disease - Purulent Bronchitis.

Time & Place of Death - 10.45 am. 15-9-18, No.3,
N.Z.G.Hospital, Codford.

Period after which Interment may take place - 3 days.

MEDICAL CASE SHEET

A.F.I.1237

2938

73523 Pte.SAVILLE J.G., 40/Rfts. Aged 31
Service 5/12.

1918

Codford Disease 404, Bronchitis (Purulent)

11-9-18

About a fortnight ago became ill.

On admission Temp.104. P.104. R.40.

Considerable cough with sputum & having
difficulty in getting sputum up.

Pulse weak, pituitrin 1 c.c. given.

Exam:- Chest: Harsh breathing all over front of
chest with crepitations.

Has diarrhoea. Rash on chest.

Mist.Expect.

Stimulants four hourly

Brandy ozs.1. four hourly.

Oxygen S.O.S.

Pituitrin $\frac{1}{2}$ c.c. S.O.S.

Heroin gr.1/12 for 12-9-18.

13-9-18 Patient very distressed but not cyanosed -
required frequent stimulation.

15-9-18. Patient ultimately became very cyanosed and
died.

(Sgd) A.Owen Johnston. Capt.
N.Z.M.C.

(COPY)

No.3, N.Z.General Hospital,
CODFORD, Wilts.
17th.Sept.1918.

POST MORTEM

73323 Pte. SAVILLE, J.G. 40th.Rfts.

DIED: 15-9-18 9.30 am. Post Mortem 16-9-18.

EXTERNAL APPEARANCE:- Well covered - Much fat on anterior abdominal wall.

ABDOMINAL VISCERA:- Appendix and Intestines, Stomach: normal. No enlargement of Ileocaecal or other groups of glands.

KIDNEYS:- Healthy - slight congestion at the base of the Pyramids.

SUPRARENALS & PANCREAS: Showed no abnormality.

SPLEEN:- Enlarged - No infarcts. The substance was soft & almost diffuent.

LIVER:- Large - Pale - Fatty in an extreme degree.

THORACIC VISCERA:- Heart. Muscle shewed pale strictions and evidence of degeneration. The left Ventricle was dilated. Valves normal. No pericarditis. Aorta: healthy.

LUNGS: (1) Left. Pleurisy over whole left lobe and in the fissure. No free fluid in pleural sac. Upper lobe shewed generalised oedema with frothy bloodstained sputum in the tubes. No pus was seen. The lower lobe anteriorly resembled the upper, but in its posterior position shewed patches of what is described as purulent Bronchitis, - dilatation of the bronchioles whose lumen is closed with a thick greenish yellow pus, while between the bronchioles the tissues are infiltrated, and even consolidated, i.e. in a condition of perobronchial or interstitial pneumonia. Superadded to the above picture was found evidence of hypostatic congestion at the base posteriorly.

(1) Right. Pleurisy present but less marked than in the left side.

The lung however was more affected. The middle lobe which was anatomically imperfect, being incompletely separated from the upper, was free from "purulent bronchitis": it was almost airless. The upper and lower lobes both shewed patches of "purulent bronchitis" and the remainder of these lobes was extremely oedematous. Postero-basal congestion was also in evidence.

(Post Mortem- continued)

OE SOPHAGUS & THYROID GLAND:- Normal.

TRACHEA:- Well marked Tracheitis throughout the entire length, and on the left anteriorlateral aspect halfway between the bifurcation and lower border of the cyicoid cartilage were two ulcers oval, and shallow. They were non-indurated, acute.

BRAINS & MENINGES:- Not examined.

Swabs taken from pus in Bronchitis.

DIAGNOSIS:- Death resulted from Bronchitis of Influenzal origin. Complicated by a Septicaemia probably pneumococcal. The terminal condition of purulent Bronchitis with generalised pulmonary oedema led to a terminal heart failure.

404 Bronchitis.

(Sgd) A. Eagleton, Capt.RAMC.
for O.C., No.3, N.Z.G.Hospital.

COPY

ARMY FORM A.27.

No.3, N.Z.General Hospital,
CODFORD, Wilts.
13th.Sept.1918.

REPORT OF DEATH.

76955 Pte. McANTEER, Claude, 40 Rfts. NZEF.

Aged 20. Religion - R.C.
Disease - Purulent Bronchitis.
Time & Place of Death - 6.30 am. 13-9-18, No.3,
N.Z G.Hospital, Codford.
Period after which Interment may take place - 3 days.

MEDICAL CASE SHEET

AF.I.1237

2888

76955 Pte. McANTEER, C. 40/Rfts. Aged 20.

1918

Service 3/12.

Codford
10-9-18

Disease 404 Bronchitis (Purulent)

About a fortnight ago became ill - headache - general pains - cough- pain in chest - very little sputum. Temp.101. P.124. R.40.

(Med. Case Sheet - contd.)

Exam:- Chest - Harsh breathing & crepitations
all over front of chest.

Treatment: Mist Expect. four hourly.

Stimulants

Brandy 1 Oz. four hourly.

Oxygen S.O.S.

Pituitrin $\frac{1}{2}$ c.c. S.O.S.

13-9-18. Patient died.

(Sgd) A.Owen-Johnston, Capt.

No.3, N.Z.General Hospital,
CODFORD, Wilts.
16th.Sept.1918.

POST MORTEM

76955. Pte. McANTEER, C. 40/Rfts.

DIED 13-9-18

P.M. 13-9-18.

EXTERNAL APPEARANCE:- Well nourished.

ABDOMINAL VISCERA:- APPENDIX. Healthy. Enlargement of
the Ileocaecal and mesenteric
glands. Petechial Haemorrhages
marked in the lower part of Jejunum
and throughout the length of the
Ilium. Enlargement of the Peyer's
patches and solitary lymph glands
close to the Ileocaecal junction.
No ulceration, No abnormality
in the colon.

LIVER: Pale. Friable. Not enlarged.

SPLEEN: Enlarged & no perisplenitis. Substance
firm.

KIDNEYS: Congestion at the base of Pyramids.
Otherwise normal.

STOMACH-PANCREAS-SUPRARENALS - Normal.

THORACIC VISCERA: THYMUS. Present and well developed.

HEART:- Right sided dilatation with slowly formed clot
in right auricle. Muscle healthy. Valves normal.
No pericarditis.

AORTA: Normal.

[Post Mortem - contd.)

LUNGS:- (1) Right. Pleurisy. Stringy shaggy lymph all over right pleura and between the lobes. The whole lung shewed dilatation of the bronchioles with oedema of intervening fissures, small portions of which sank in water. Signs of old tuberculous lesion at the apex. Bronchioles were full of Viscid greenish yellow pus.
(2) Left. Pleurisy present only on the posterior aspect of the lower lobe and here only shown by a dulling of the normal glistening surface. The lung showed the same signs as the right, but in addition it was noted that the tissue was extremely friable in placed and in one portion of the upper lobe a ragged cavity was present.

ÆSOPHAGUS:- Normal.

THYROID GLAND:- Showed small cavities - no acute inflammation.

TRACHEA:- Very marked inflammation. No ulceration but the condition suggested that this might have supervened. Great enlargement and softening of the glands at the bifurcation.

LARYNX:- Normal.

BRAIN & MENINGES:- Not examined.

DIAGNOSIS:- Death resulted from acute "Purulent Bronchitis" and Septicaemia, the fatal event being directly due to right sided heart failure.

Swabs taken from spleen and Bronchial Secretion showed on Culture:-

Spleen Culture:- Negative.

Bronchial Secretion Culture:- B.Influenzae and a few colonies Streptococcus aureus.

(Sgd) A.J. Eagleton ,

Capt. R.A.M.C.

for O.C., No.3, N.Z.General Hospital.

Brief notes on Epidemic No.3 at the N.Z.Camp, Brocton.

It was intended to refer in detail to this outbreak but in many respects it so closely resembles the earlier epidemics that for sake of brevity mention will merely be made of points of difference.

HISTORY.

On Oct. 23rd. 1918 a few men reported sick with symptoms of severe influenza, next day 90 cases occurred and the epidemic developed with great rapidity. Over a thousand men were affected equal to 36 per cent of the total strength, and of these 30 per cent developed pulmonary complications. The mortality was 49, slightly less than 5 per cent of those attacked.

CLINICAL FEATURES.

The severer cases were removed to Rugeley Hospital, presenting the clinical appearances of commencing pneumonia. The large majority developed broncho-pneumonia, several were lobar in type but very few cases of purulent bronchitis occurred. In this respect the 3rd. epidemic differed from the others in which the latter condition preponderated. Some of the patients expectorated a thick purulent sputum but not profuse as in the earlier outbreaks. A strong point of resemblance however was the marked cyanosis in most cases, with peculiar purple hue which one has come to associated with streptococcal toxæmia.

PATHOLOGICAL ANATOMY.

At the autopsies a feature common to all cases was the intense congestion of the respiratory tract

with ulceration, almost identical with the condition found previously. Section of the lung showed in by far the larger number of cases, definite patches of consolidation typical of broncho pneumonia. Others were purely lobar, in a few both conditions occurred but rarely did a purulent bronchitis exist alone. Generally a lower lobe and part of an upper in the same lung were consolidated but the patches were more intensely red than is usual in the stage of red hepatisation. It was rare to find a pneumonic condition of both lungs. As already mentioned in the general survey the stage of consolidation did not usually coincide with the duration of the illness, which had continued with high temperature for several days before the expected physical signs of pneumonia appeared. This occurs where the consolidation commences centrally in a deep seated focus and gradually extends towards the surface of the lung but its frequency in this epidemic was remarkable.

The pathological conditions of the lungs was in most respects consistent with one or other form of pneumonia and therefore differed from that of the earlier epidemics in which consolidation was exceptional.

In nearly all cases examined the right side of the heart was dilated and engorged. Other organs were either normal or presented an appearance similar to that previously described.

Common to all was an enlargement of the bronchial glands.

It is regretted that owing to the acute shortage of medical officers at the Rugeley Hospital and the severe and prolonged strain on the limited staff, it was not possible to examine the cases bacteriologically and supply details of the findings. These would have proved interesting in determining the particular organisms responsible for the infection.

SUMMARY OF THE MAIN POINTS ADDUCED.

The investigation of cases of Infective Respiratory Catarrh occurring during the N.Z. epidemics elicits several points of importance which will be summarized under the following headings:-

1. Susceptibility of N.Z. troops to infection.
2. The condition termed "purulent bronchitis".
3. Nature of bacteria concerned.
4. Prevention.
5. Treatment.

1. SUSCEPTIBILITY TO INFECTION.

There is no evidence as previously supposed and still asserted that the prevalence of infective diseases of the respiratory tract among N.Z. troops is owing to undue susceptibility to catarrhal conditions. As an indication that such is not the case is the still higher mortality from similar causes among American troops in Europe, also that the incidence among New Zealanders compares favourably with other overseas troops.

The unfortunate result of the epidemics under review may be explained as due to a combination of circumstances causing a lowered resistance to infection. Chief of these are:-

- (a) Overcrowding of transports and the debilitating effect of a protracted sea voyage;
- (b) Insanitary conditions in transit due to defective ventilation when passing through the submarine danger zone during the latter part of the voyage. This was undoubtedly the main contributing cause of the high mortality and operated in all three instances.
- (c) Lack of natural immunity. - The large majority of the men forming reinforcements were unprotected by previous attacks of infectious disease. This especially applies to measles, as was demonstrated during the first epidemic. The influenza hitherto experienced in New Zealand was of a mild type and a previous attack would afford little or no immunity to the more virulent form which later attacked them.

Probably all three factors (a), (b), and (c) operated in many cases in view of the fact that the mortality occurred among recent reinforcements.

For several years previous to the war it was found that over 95 per cent of cases of influenza and pneumonia were associated with ~~a~~ pneumococcus, not the B. influenza or a streptococcus. The infection among N.Z. troops in England was chiefly streptococcic against which they had acquired no immunity.

2. PURULENT BRONCHITIS.

This condition was associated with nearly all the deaths in the first and second epidemics. How far the development of purulent bronchitis is influenced by an acute antecedent ^{disease} is not clear nor can we yet explain why an identical pulmonary complication in the 1st. and 2nd. epidemics should be associated in the one case with an outbreak of measles and in the other with influenza. The result of our observations tends to prove that purulent bronchitis is quite distinct from pneumonia both as regards etiology, clinical manifestations and pathology. Some of the most severe and fatal cases displayed no physical signs of consolidation and the clinical observations have been verified by autopsy. The chest may remain resonant on percussion throughout or slight impairment appear at the bases. The adventitious sounds occurring in different areas tend towards the bronchitis type, it is unusual to find tubular breathing and other indications of pneumonia. Briefly there does not appear to be sufficient in the pathological phenomena of purulent bronchitis alone to explain the high mortality. To what then is it due?

3. NATURE OF BACTERIA CONCERNED

Streptococci are invariably present in the affected lung and often in large numbers in the fibrinous exudate on the pleural surface. In the 12 cases from which post mortem cultures were made

during the first outbreak, the streptococcus was the only organism isolated in every instance. The very marked heliotrope cyanosis which has so impressed all observers is not consistent with the cardiac or pulmonary condition and strongly suggests a profound streptococcic toxæmia as the cause. There is evidence that where both pneumococci and streptococci coexist the latter are not so freely destroyed by the phagocytes as are the pneumococci and their persistence establishes the close association between the streptococcus and purulent bronchitis.

The role of the B.influenza is still uncertain. It was clearly associated with the 2nd. and 3rd. epidemics yet during the period of the 1st. epidemic at Sling did not participate although there were in the same camp 303 cases clinically diagnosed as influenza. The sputa of many of these men were examined, B.influenza was found in 40 per cent and streptococci in all but no pulmonary complications ensued. Several possible explanations are suggested:-

(a) The streptococcus may vary in potency, being only dangerous when especially virulent and present in strong force.

(b) A symbiosis or close co-operation between certain types and strains of streptococci with B.influenza or a causal organism of influenza still unknown.

(c) A similar symbiosis between (b) and certain types of the pneumococcus.

(d) The preparation of a suitable soil by an acute infectious disease immediately antecedent to infection by the strptococcus or pneumococcus, and which induces a catarrh of the respiratory tract rendering it more vulnerable to bacterial invasion.

From our experience of the epidemics Class (d) would appear to be an essential factor and in co-operation with (b) offers a reasonable explanation of the first and second outbreaks in both of which a condition of respiratory catarrh preceded streptococcic infection. Class (a) is a possible factor but has not been proved.

In the outbreaks of purulent bronchitis reported in the "Lancet" of July 14th. 1917, page 41, and Sept. 8th. 1917, page 377, the combination of B. influenza and the pneumococcus was regarded as the cause. In our experience of the 1st. and 2nd. epidemics pneumococcus was rare and in the cultures from 12 autopsies already referred to was only isolated in one fourth of the cases. Its occurrence is, of course, usually in the more typical pneumonias.

Briefly the evidence strongly points to a streptococcus as the specific cause, under certain conditions, of purulent bronchitis, also that it is usually associated with the pneumococcus in lobular or lobar pneumonia.

It is much to be regretted that bacteriologists, owing to the many difficulties and disadvantages incidental to the war, have not been able to devote the necessary attention to the differentiation of the

various types of streptococci concerned in the development of pulmonary complications. Further investigation will do much to solve problems in etiology at present inexplicable.

4. PREVENTION.

This includes all measures by which the physical health is improved, e.g. regular periods of rest, proper and sufficient food, congenial and sanitary surroundings, and open air exercise. These are all important factors in increasing the resistance of the body to infection. In addition we must consider:-

- (a) Limitation of infection;
- (b) Inoculation.

(a) Limitation of infection.- It is impossible to over estimate the danger of disregarding measures for limiting the distribution of the infective organisms which are so intimately concerned with outbreaks of acute respiratory disease. This control may be promoted by Isolation and "Masking".

Isolation.- The series results of contact infection have been abundantly proved and the isolation of "carriers" and patients in the infective stage should be carried out to as great an extent as is practicable.

"Masking".- This method has been freely adopted in America to prevent the dissemination of infective material and great success is claimed. The universal masking during an epidemic is, for obvious reasons, not practicable. There is however no sound objection to its use by those who, from necessity, come into

contact with infectious cases.

(b) Inoculation.— The evidence adduced is strongly in favour of prophylactic inoculation with a suitable vaccine. It is admitted that much scientific research is yet required to clearly establish the relationship of the streptococcus and other organisms to respiratory catarrh also to determine the various types and strains more particularly of the streptococcus. Until this is accomplished we cannot expect the best results, for a vaccine must contain the necessary constituents properly prepared and administered in adequate dosage. For instance, American observers have demonstrated the extraordinary virulence of the streptococcus haemolyticus, its constant association with interstitial broncho pneumonia, and have therefore included this organism in the prophylactic vaccine for the disease. The inoculation against typhoid was only completely successful when its various types were recognised and a vaccine prepared accordingly. There is therefore no reason why further investigation should not lead to equally beneficial results in combating the streptococcus. To confer an immunity to a disease with such an appalling death rate is a consummation worthy of strenuous and continued effort, moreover its success would obviate to a large extent the necessity of other preventive measures.

5. TREATMENT.

There is so far no specific treatment and we have to rely on dealing with symptoms as they arise.

Vaccine Therapy.— The high expectations regarding this form of treatment have not yet been realised.

but the indications are certainly encouraging. The variable results are undoubtedly due to vague and imperfect knowledge of the types and characteristics of the organisms concerned in pulmonary complications. Much has been accomplished in this direction with regard to the pneumococcus and it is now recognised that success in vaccine therapy depends upon the inclusion in the vaccine of organisms homologous in type with those causing the disease.

The investigations regarding the streptococcus are now on a rational and scientific basis, and we may confidently hope for results which will remove the reproach that medical science is helpless and doing little or nothing to check the epidemics ~~that~~ which have become a national calamity.